Information System for Clinical Echocardiography Laboratory

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We have developed a prototype Information System for the echocardiography laboratory, which consists of 1) relational database, 2) graphical user interface, 3) intelligent report writer, and 4) image processing. The system was developed using VAXstation 3500 (Digital Equipment Corporation) running the VMS operating system and DECwindows, Ingres (ASK/Ingres) relational database, and HP SONOS 1500 (Hewlett-Packard) echocardiographic system with optical disk.

More then 600 numeric, textual, and logical echocardiographic variables were identified and arranged into entity-relationship scheme according to their patho-anatomical relation, and represented in 32 database relations.

A multilayered graphical user interface was developed using Ingres Windows/4GL environment. The interface provides read and write access to the data and eliminates data ambiguity immediately during data input. Domain knowledge represented by more then 80 rules, lists of legal values, and normal values ranges, is embedded in the interface. Graphical representation of anatomic structures is also provided for easy reference.

The interface is designed to react dynamically to the changes in the data, and to present users selectively with data and control elements. For example, if the patient has only native valves, no attributes representing conditions of prosthetic valves will be displayed. Additional layers of the interface are activated whenever more detailed representation of a structure or disease is desirable. On the other hand, just one form is necessary for a normal heart.

Quantitative values are compared with normal values stored in the system, and when a value in excess of two standard deviations is detected, a message alerting the user to the same is displayed. If a value could not be evaluated due to poor image quality, the null value representing 'not seen' condition is stored.

Users of the system are grouped according to their needs and privileges. Data protection is guaranteed by a two-levels system of passwords. Only read access is honored once data are confirmed by the attending physician.

Previous attempts to analyze the interpretations of the data by computerized method of text processing demonstrated that a substantial effort is necessary to accommodate interpersonal differences. We have used a reversed approach: the values are entered into the database first, and then the report writer is activated to generate the text. The attributes in the database have well-defined semantics, for which a general consensus is easier to reach. Every attribute in the database is defined by domain expert, and the definition is available on-line during interaction with the system. Standardization of the data in the database, and therefore data integrity, is thus enforced.

A program module has been developed for reporting that generates English-like sentences by matching values in the database with internally stored knowledge. The module is written in the C programming language, with embedded knowledge base consisting of several dozens of IF-THEN-ELSE rules. A standard text processor (WordPerfect, WordPerfect Corp.) is used to compile and output patient reports over the computer network, on the printer or FAX. WordPerfect imports blocks of generated text in a mail merge fashion into the predefined report forms.

Echocardiography also comprises several formats of still and live video, audio, and graphics. Sequences of frames and still frames were digitized from VHS or S-VHS video tapes using HP SONOS 1500, stored on the internal optical disk, and imported into the database. The images are stored as external objects, and will be transformed into internal Binary Large Objects (BLOBs) using Ingres Object Management extension in the future.

A model workstation (referred elsewhere) has also been developed using Apple Macintosh Quadra 950 to assist us to incorporate video, color video, and audio objects into the Information System, and to evaluate feasibility of compression of the echocardiographic data.

Conclusion:

A comprehensive and flexible information system has been developed for the echocardiographic laboratory. The system is designed to easily assimilate future innovative trends in order to mature into an information backbone of the cardiology department.

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